The Purpose of Visualization

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CS 558: Visualization
Winter 2005

Why do we create visualizations?

Why do we create visualizations?

- Answer a question
- Make decisions
- See data in context
- Analyze and discover
- Present an argument
- Tell a story
- Inspire

Three functions of visualizations

Record information

- Photographs, blueprints,

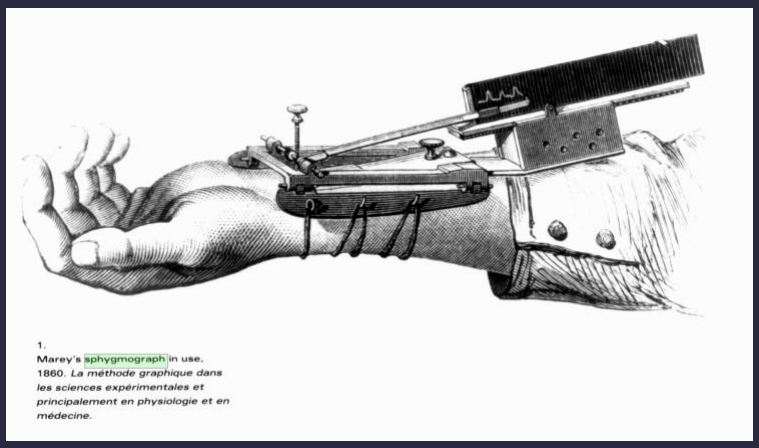
Explore information (analyze)

- Process and calculate
- Reason about data
- Feedback and interaction

Explain information (present)

- Share and persuade
- Collaborate and revise
- Emphasize important aspects of data

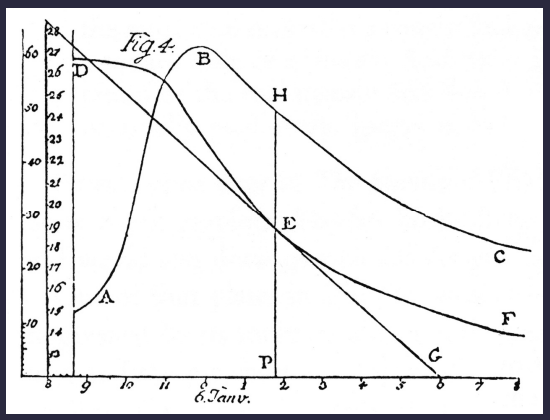
Record information

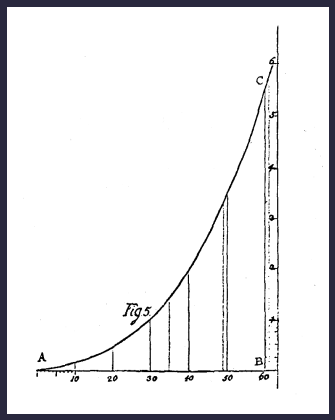


1.
Marey's sphygmograph in use.
1860. *La méthode graphique dans les sciences expérimentales et principalement en physiologie et en médecine.*

E.J. Marey built a syphygmograph to graphically record pulse [from Braun 83]

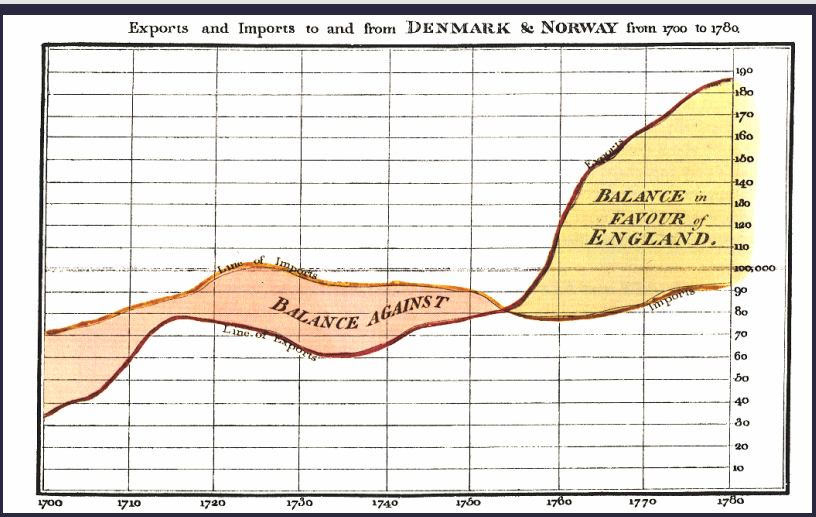
Explore information (analyze)





Johannes Lambert used graphs to study the rate of water evaporation as function of temperature [from Tufte 83]

Explain information (present)



[Playfair 1786]

The purpose of visualization is to convey information

The most powerful brain?

Microsoft Excel - animal.xls

File Edit View Insert Format Tools Data Window Help

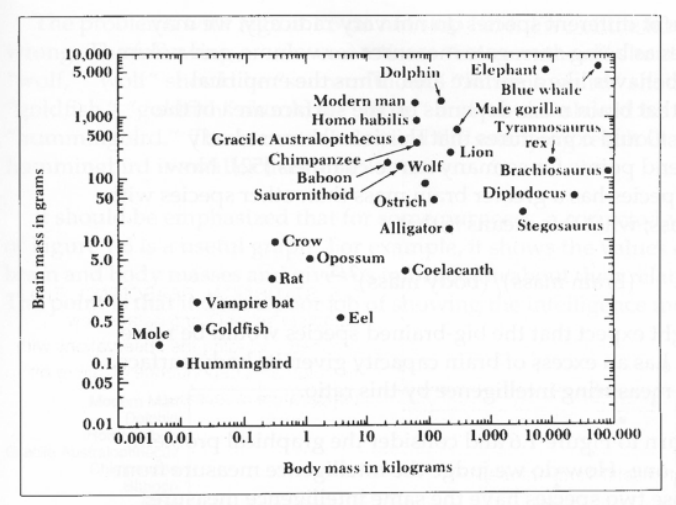
A1 ID

	A	B	C	D	E
1	ID	Name	Body Weight	Brain Weight	
2	1	Lesser Short-tailed Shrew	5	0.14	
3	2	Little Brown Bat	10	0.25	
4	3	Mouse	23	0.3	
5	4	Big Brown Bat	23	0.4	
6	5	Musk Shrew	48	0.33	
7	6	Star Nosed Mole	60	1	
8	7	Eastern American Mole	75	1.2	
9	8	Ground Squirrel	101	4	
10	9	Tree Shrew	104	2.5	
11	10	Golden Hamster	120	1	
12	11	Mole Rate	122	3	
13	12	Galago	200	5	
14	13	Rat	280	1.9	
15	14	Chinchilla	425	6.4	
16	15	Desert Hedgehog	550	2.4	
17	16	Rock Hyrax (a)	750	12.3	
18	17	European Hedgehog	785	3.5	
19	18	Tenrec	900	2.6	
20	19	Arctic Ground Squirrel	920	5.7	
21	20	African Giant Pouched Rat	1000	6.6	
22	21	Guinea Pig	1040	5.5	
23	22	Mountain Beaver	1350	8.1	
24	23	Slow Loris	1400	12.5	
25	24	Genet	1410	17.5	
26	25	Phalanger	1620	11.4	

animal

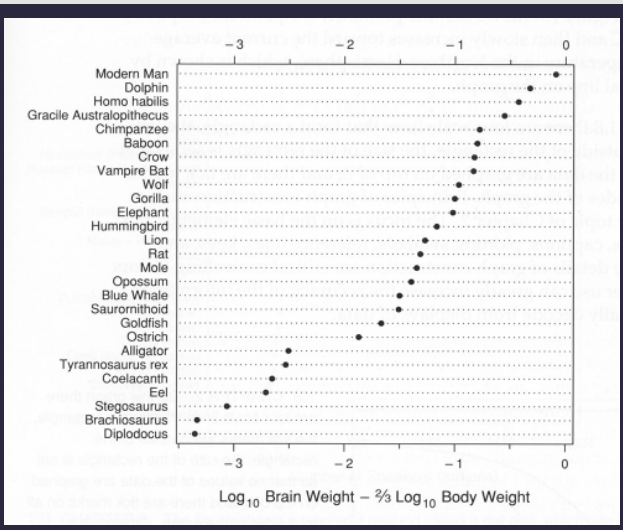
Ready

The most powerful brain?



The Dragons of Eden [Carl Sagan]

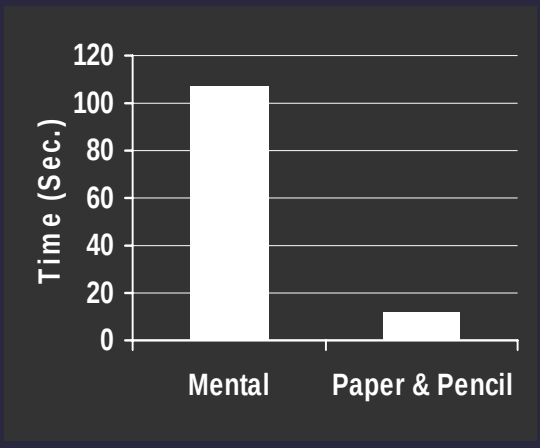
The most powerful brain?



The Elements of Graping Data [Cleveland]

Expand working memory

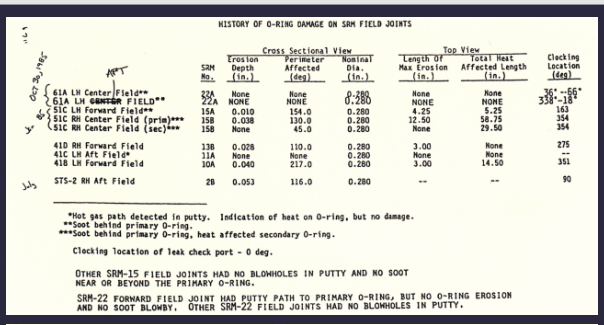
```
  34
x 72
----
  68
2380
----
2448
```



Cholera outbreak in 1864, London

John Snow plotted the position of each case on a map. Used map to hypothesize that pump on Broad St. was the cause. [from Tufte 83]

Challenger disaster



HISTORY OF O-RING DAMAGE ON SRM FIELD JOINTS

	SRM No.	Cross Sectional View: Erosion Depth (in.)	Cross Sectional View: Perimeter Affected (deg)	Cross Sectional View: Nominal Dia. (in.)	Top View: Length Of Max Erosion (in.)	Top View: Total Heat Affected Length (in.)	Clocking Location (deg)
61A LH Center Field**	22A	None	None	0.280	None	None	36°-66°
61A LH CENTER FIELD**	22A	NONE	NONE	0.280	NONE	NONE	338°-18°
51C LH Forward Field**	15A	0.010	154.0	0.280	4.25	5.25	163
51C RH Center Field (prim)***	15B	0.038	130.0	0.280	12.50	58.75	354
51C RH Center Field (sec)***	15B	None	45.0	0.280	None	29.50	354
41D RH Forward Field	13B	0.028	110.0	0.280	3.00	None	275
41C LH Aft Field*	11A	None	None	0.280	None	None	--
41B LH Forward Field	10A	0.040	217.0	0.280	3.00	14.50	351
STS-2 RH Aft Field	2B	0.053	116.0	0.280	--	--	90

*Hot gas path detected in putty. Indication of heat on O-ring, but no damage.
**Soot behind primary O-ring.
***Soot behind primary O-ring, heat affected secondary O-ring.

Clocking location of leak check port - 0 deg.

OTHER SRM-15 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY AND NO SOOT NEAR OR BEYOND THE PRIMARY O-RING.

SRM-22 FORWARD FIELD JOINT HAD PUTTY PATH TO PRIMARY O-RING, BUT NO O-RING EROSION AND NO SOOT BLOWBY. OTHER SRM-22 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY.

Blow By History
SRM-15 Worst Blow-By
- 2 case joints (80°), (110°) Asc
- Much worse visually than SRM-22

SRM 22 Blow-By
- 2 case joints (30-40°)

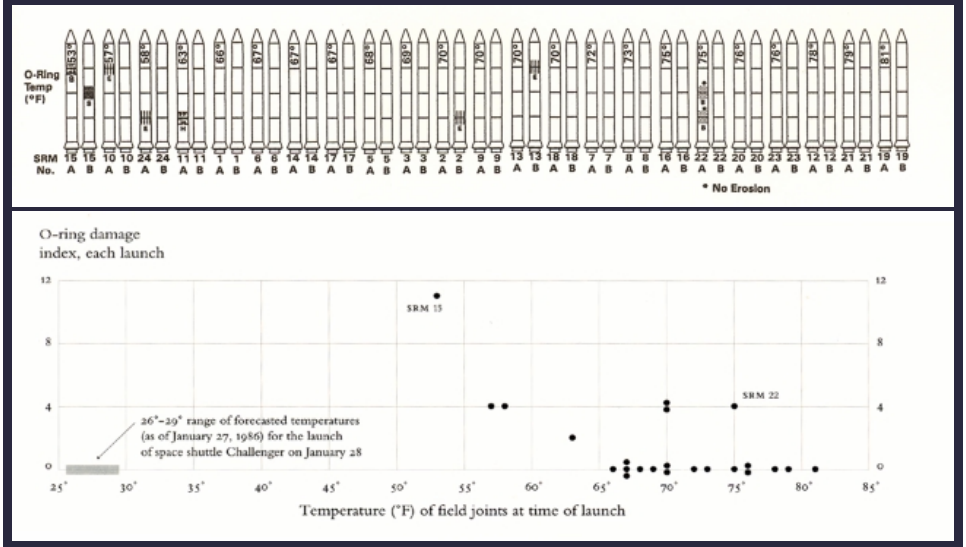
SRM-13A, 15, 16A, 18, 23A 24A
- Nozzle Blow-By

HISTORY OF O-RING TEMPERATURES (DEGREES-F)

MOTOR	MBT	AMB	O-RING	WIND
DM-1	68	36	47	10 MPH
DM-2	76	45	52	10 MPH
QM-3	72.5	40	48	10 MPH
QM-4	76	48	51	10 MPH
SRM-15	52	64	53	10 MPH
SRM-22	77	78	75	10 MPH
SRM-25	55	26	29 27	10 MPH 25 MPH

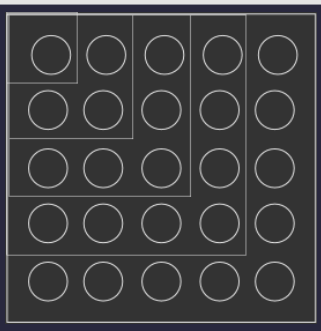
2 of 13 pages of material faxed to NASA by Morton Thiokol

Challenger disaster

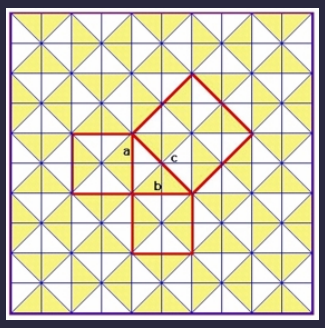


Visualizations drawn by Tufte show how low temperatures damage O-rings [Tufte 97]

Visual proofs



Sum of odd numbers:
$1 + 3 + 5 + 7 + 9 = 5^2$



Pythagorean theorem:
Chinese proof by dissection

Amplifies perception & cognition

1. Expand working memory
2. Reduce search time
3. Pattern detection and recognition
4. Perceptual inference
5. Perceptual monitoring & controlling attention
6. Interaction to aid cognition

Using vision to think

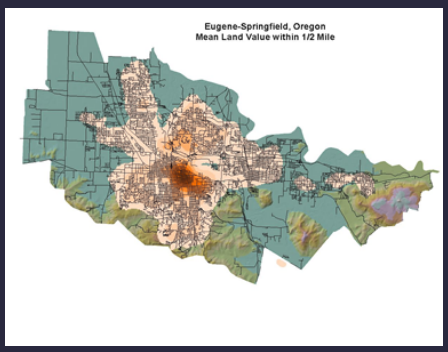
Readings in Information Visualization, Chapter 1 [Card 99]

Visualization Research

Challenge

Computing becoming ubiquitous

- Faster creation and collection of data



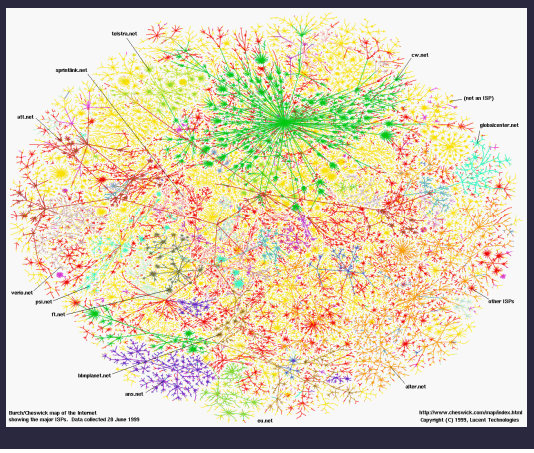
Simulation
UrbanSim – urban development planning
Generates many classes of output data

Sensing
Sloan digital sky survey
Robotic telescope - 40 TB of imagery

Challenge

Computing becoming ubiquitous

- Faster creation and collection of data
- Faster dissemination of data



Map of the Internet
http://research.lumeta.com/ches/map/

Challenge

Computing becoming ubiquitous

- Faster creation and collection of data
- Faster dissemination of data

Need better tools to produce visualizations

Goals of visualization research

1. Understand how visualizations convey information to people

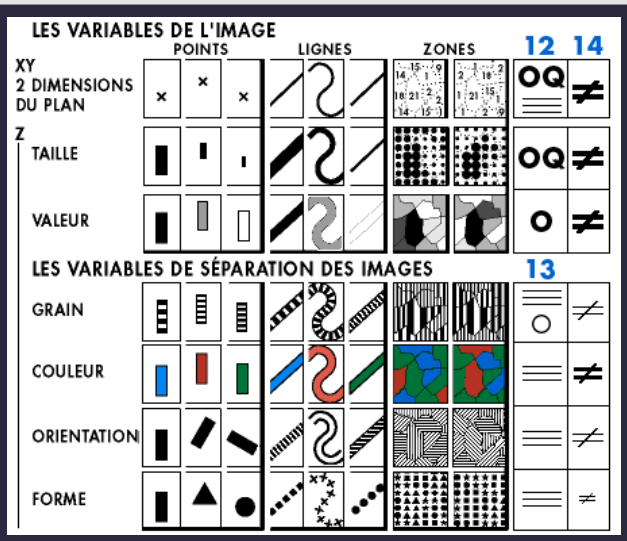
- What do people perceive/comprehend ?
- How do visualizations correspond with mental models of data?

2. Develop principles and techniques for creating effective visualizations

- Amplify perception and cognition
- Strengthen connection between visualization and mental model of data

Topics

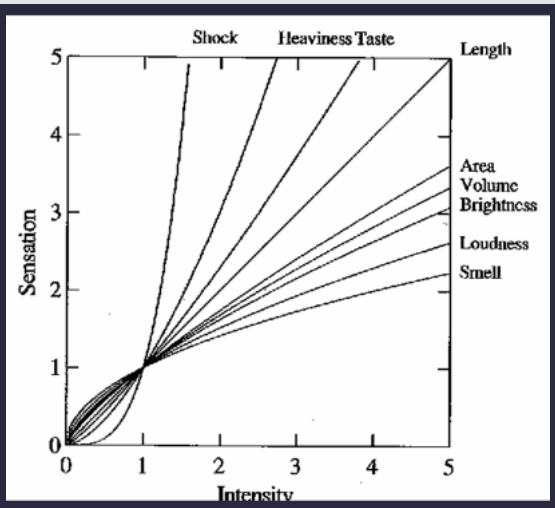
1. Data and image models



[Bertin, Graphics and Graphic Information Processing 1981]

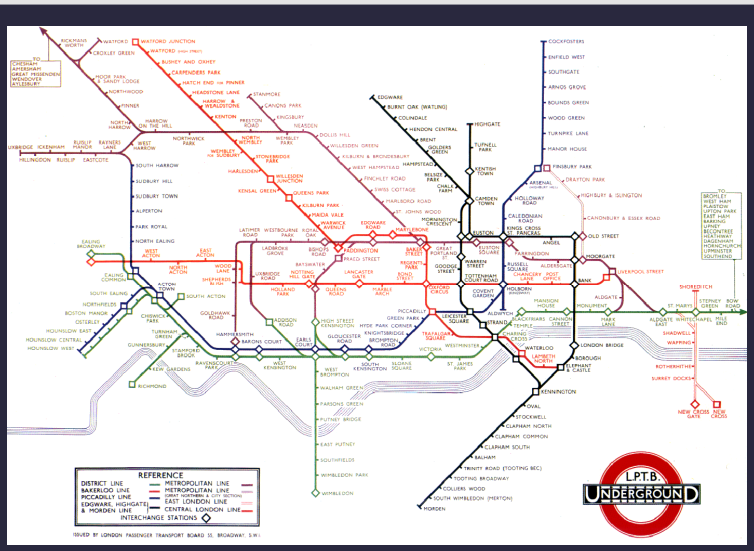
http://www.sciences-po.fr/cartographie/cartographie_html/5_page5theorie/graphique_bertin2001/03_%20propietes_en_z/03_1_proprietes_du_z.html

2. Perception



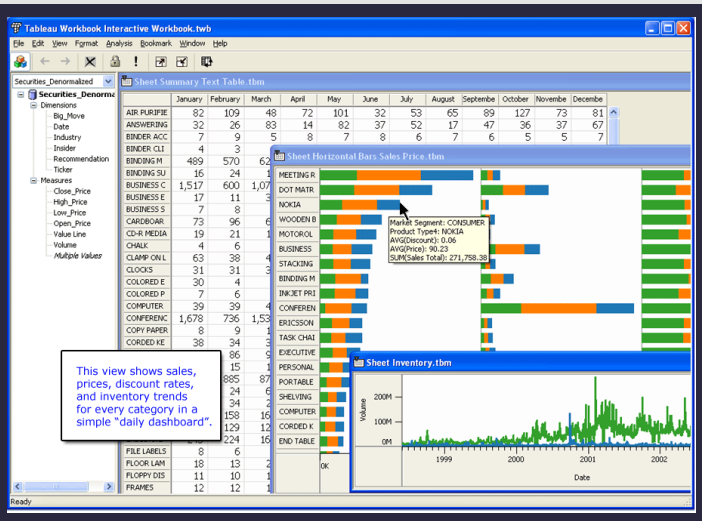
The psychophysics of sensory function [Stevens 61]

3. Spatial Layout



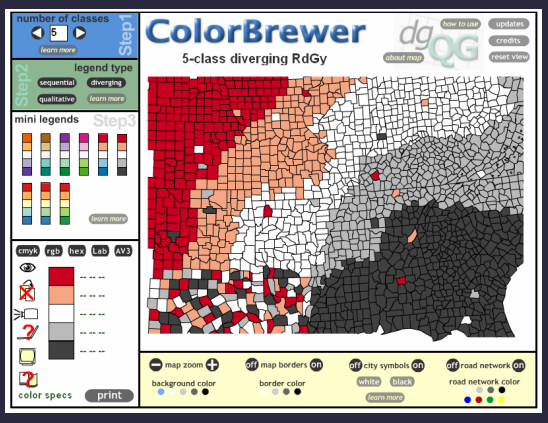
London underground [Beck 33]

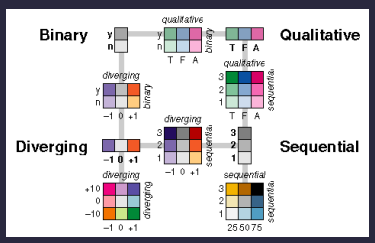
4. Database visualization



Guest lecture: Chris Stolte from Tableau software

5. Color

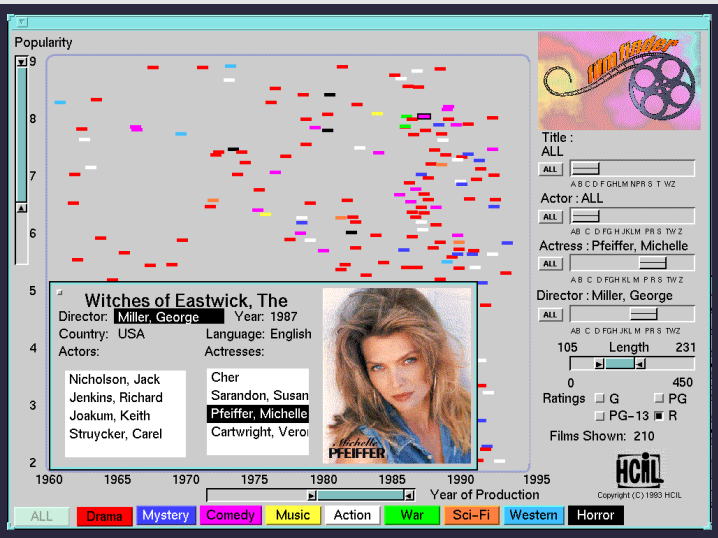




[from Cynthia Brewer http://www.personal.psu.edu/faculty/c/a/cab38/]

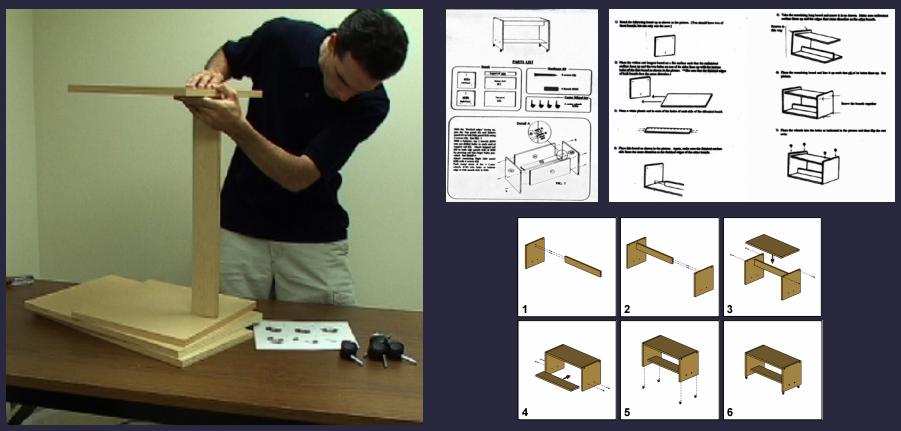
Guest lecture: Maureen Stone

6. Interaction



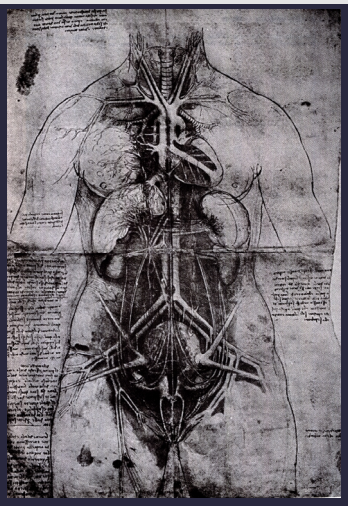
FilmFinder [Ahlberg 94]

7. Usability and evaluation

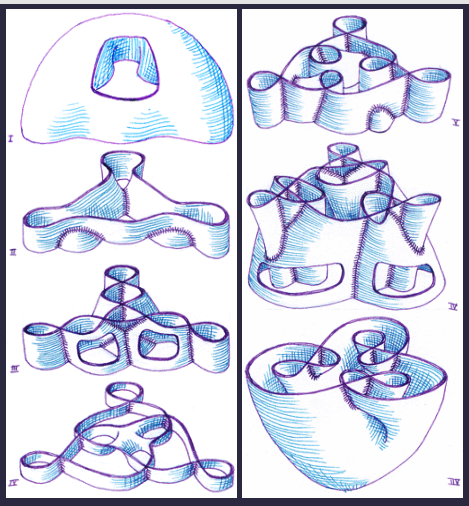


Testing effectiveness of 3 types of assembly instructions [Heiser 04]

8. Conveying shape and structure



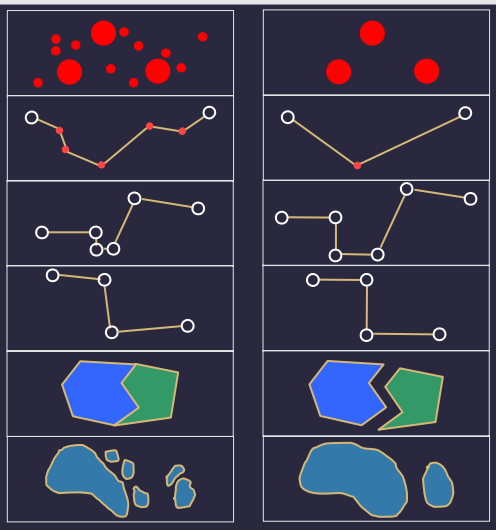
Principal Organs & Vascular System
[Leonardo da Vinci ca. 1490]



Strange Immersion of Torus in
3-Space [Curtis 92]

9. Abstraction, emphasis & LOD

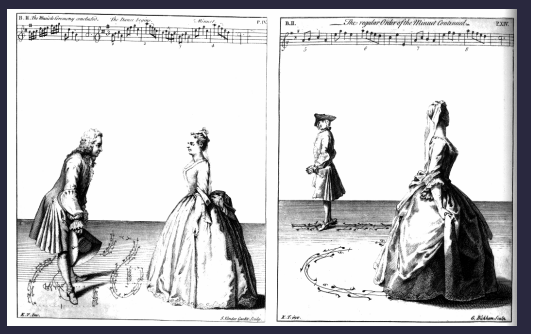
- Selection
- Simplification
- Exaggeration
- Regularization
- Displacement
- Aggregation



Cartographic generalization techniques [Monmonier 96] [MacEachren 94] [DiBiase 91]

10. Depicting processes & actions

Wearing a sari [from Mijksenaar 99]



Visualizing dance steps [from Tufte 90]

Course Mechanics

Structure

Lectures

- In general I'll present one lecture each week
- You'll lead the other presentation/discussion
- Material in class will be loosely based on readings

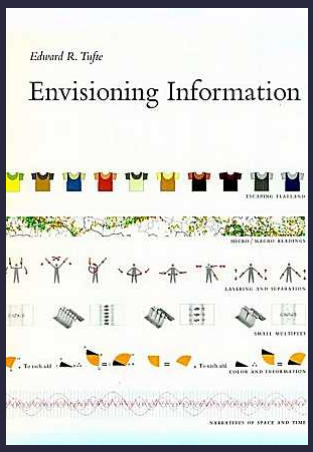
Requirements

- Presentation
- Assignment 1: Find good and bad visualizations
- Assignment 2: Create a visualization
- Final project

Class home page
http://abstract.cs.washington.edu/~maneesh/cs558/

Textbook

Envisioning Information by Edward Tufte



Presentations

Describe visualization problems and techniques for a specific domain

- Cartographic visualization
- Molecular visualization
- Tree and graph layout
- Software visualization
- Flow visualization
- Medical imaging
- Anatomical illustration
- Video-game visualization
- Visualization of sporting events
- Social network visualization
- Financial visualization
- Music visualization

Signup for topic on Jan 11. Groups of 2 ok. First group Jan 18.
http://abstract.cs.washington.edu/~maneesh/cs558/presentations.html

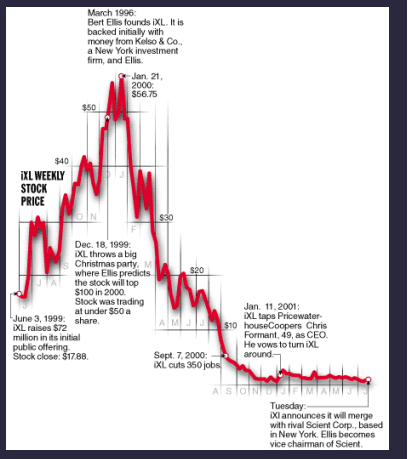
Assignment 1

Find two visualizations one *bad* and one *good*

Use original sources

- Journals
- Science magazines
- Newspapers
- Textbooks

Make webpage explaining the images and critiquing them



Due Jan 11. Mail me URL by 10am.
http://abstract.cs.washington.edu/~maneesh/cs558/assignment1.html

History

Pat Hanrahan taught visualization class in 2002

He revised it in 2004

http://www.graphics.stanford.edu/courses/cs448b-04-winter/

Many lectures will be adapted from Pat's classes

Other visualization classes:

- Tamara Munzner (UBC)
- John Stasko (Georgia Tech.)
- Marti Hearst (Berkeley)